# N.A.C.A. BULLETIN

In Three Sections

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VOL. XXIX, NO. 14 MARCH 15, 1948

## EDITORIAL DEPARTMENT NOTE

Foundry costs are equally a concern of many large manufacturers and many small ones and have been written on somewhat less frequently than is appropriate in the light of this broad general interest. The four articles in this issue constitute as many brief, practical approaches to aspects of foundry costing. The initial presentation covers the cost procedures of a company producing gray iron castings for its own use and for the market.

The author is HUBERT L. DYER, Chief Cost Accountant of the several divisions of the Lufkin Foundry & Machine Co., Lufkin, Texas. Mr. Dyer entered the employ of his company as a junior accountant in 1933 after two years in banking in the same city.

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How to distribute foundry costs to departments and then to lines and products is a problem which does not yield a ready solution. One method is illustrated in our second article which deals with the operations of a malleable and gray iron foundry.

The article is written by PERCY J. ESLING, who holds the position of Cost Supervisor of the Malleable and Gray Iron Division of the Detroit Brass & Malleable Works, Wyandotte, Mich. Mr. Esling first became connected with the foundry industry more than twenty years ago and later served as Assistant Secretary and Treasurer of Albion Malleable Iron Co.

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There are jobbing foundries and so-called captive foundries contributing to a larger enterprise, and there are also foundries making castings promptly assembled into a standard product line. The last-named type of operation is reflected in the third article in this issue, which sets forth a method of production control devised with the needs of the foreman in mind.

H. LEON ABERNATHY, Chief Accountant of the Chattanooga Implement & Mfg. Co., is the author of the presentation. Mr. Abernathy, who has long been a resident of Chattanooga, has been active in foundry circles in the south. He is immediate Past President of Chattanooga Chapter of N. A. C. A.

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The group of articles on foundry costs closes with the description of a method followed by one foundry making castings from aluminum, brass, nickel alloys, and stainless steel, to assign all costs to business done in each metal group with individual customers so that the relative profitability of accounts may be a matter of record.

BETTY GAY WISE, Cost Department Supervisor, Waukesha Foundry Co., Waukesha, Wis., is the author of this article. Miss Wise has been connected with the company since 1941. After graduation from the School of Business Administration of the University of Minnesota in 1938, she engaged in sales statistics and cost accounting work with other companies before coming to her present employer.

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MARCH 15, 1948

# COSTING FOR PRICING AND CONTROL IN A GRAY IRON FOUNDRY

by HUBERT L. DYER, Chief Cost Accountant,
Lufkin Foundry & Machine Co.,
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IN THE gray iron castings industry where as a rule the castings are produced in accordance with a design and specification furnished by the buyer, it is of utmost importance to obtain accurate costs on an individual casting basis. Quotations to prospective customers are usually made as a price per pound or a price for each casting or pattern. In order to secure repeat orders as well as to operate the foundry with a reasonable profit, the management must be in a position to know all the elements of its cost of operations. While it is not claimed that there is anything new in the cost procedures presented in this discussion, the methods of obtaining actual or job costs and comparing the results with standards may be of interest to some who have met and solved similar problems as well as to others who may in the future be faced with similar situations.

### *Features of the Operation*

The Gray Iron Foundry Division of the Lufkin Foundry & Machine Company produces castings which are used in the manufacture of oil-field pumping equipment, gas engines, gear reducers, and speed increasers. Castings are also sold commercially to others on a job lot basis. The cost accounting system in use at this plant is designed to give information through which a selling price can be established on the complete units produced and distributed direct to the ultimate user as well as provide a basis for pricing the individual castings for other customers. A cost per piece is established on all classes or patterns of castings produced.

A large number of the castings from this foundry are moved into the machining divisions where various machine operations are performed. The machined iron castings are then sent to the assembly lines where complete geared units are assembled, tested and inspected, painted, and sent to the final assembly department for assembly with parts fabricated and welded in other parts of the plant. These castings vary in size from less than one pound to over 12,000 pounds. Special castings are made weighing up to

30,000 pounds. The foundry operates two cupola furnaces with a daily capacity of 150 tons.

The labor cost of operating the foundry is obtained through the use of individual time cards having spaces provided for recording such information as the worker's name, clock number, department, production order number, hours worked, and columns for the use of the accounting department in making the proper payroll distribution. Labor distributions are made daily, the direct labor forming the basis for the individual castings cost record. The indirect labor is accumulated and charged against the department or cost center responsible for the expense.

*Uses of Standard Hours and Standard Costs*

As previously mentioned the cost method used is that of obtaining actual or job costs. However, considerable use is made of standards in measuring actual hours for producing castings as compared with carefully determined standards which are based on a scientific study combined with experience in producing the same or similar castings in the past. It has been our experience that the use of actual costs in pricing will lead to many errors in making quotations and in inventory valuation unless current operations are compared with predetermined standards. The possibility of high scrap losses in the foundry, as well as low production in slack periods of business, make the use of standards invaluable. Cost of sales accounts priced at standard enable us to prepare the over-all monthly profit and loss statement for all plants and subdivisions of the company quickly with less clerical work and with greater accuracy.

The use of standard hours as set for pricing has also been employed to great advantage in a cost control program. Reports to foremen make use of comparisons between actual hours for the various operations under their control and standard times. Variations are investigated immediately and corrective measures are undertaken. The reports issued to the foremen are brief and cover only the operations over which each exercises some means of control, since it is the policy of this plant to keep to a low minimum the paper work required of the foremen. An example of a weekly report issued to foremen is shown as Exhibit 1.

The scheduling or routing of work through the foundry is coordinated with that of the machine shops, since the manufacture and shipping dates of the complete units are planned for long

REPORT TO FOREMEN

Prepared for: Foremen of Department "C"
Period: Week ending November 8, 1947

| Actual hours of operations | | Standard hours of operations | |
|---|---|---|---|
| Direct | 1267 | Direct | 1205 |
| Indirect | 339 | Indirect | 317 |
| Total | 1606 | Total | 1522 |

Over-all performance record for department.....94.8%

Reasons for excess hours:

| | |
|---|---|
| Workers' failures | 63 |
| Waiting for materials | 9 |
| Breakdowns | 7 |
| Other | 5 |
| Total | 84 |

EXHIBIT I

periods in advance of actual work. Castings must be available in ample time for machining operations to be completed so that shipping dates can be maintained. The routing of work through the foundry itself with correct planning so that all departments have the proper amount of work calls for careful and accurate scheduling. The manufacturing orders for all plants are issued by a central order department working from the stock records of the material control department. These orders are used as the basis for scheduling and furnish a means for the recording of direct labor and material chargeable to the individual job.

*Classification of Accounts*

The departments of the gray iron foundry consist of melting, molding, core, cleaning, and pattern. A detailed classification of accounts is maintained for each department consisting of direct labor and the overhead accounts of indirect labor, supplies, depreciation, etc. The successful operation of a foundry cost system depends to a large degree upon maintaining a good classification of accounts and distributing all items of cost to the proper cost center. A further classification is maintained for general expense such as insurance, taxes, and general salaries. These are allocated to the productive departments on various sound bases depending upon the nature of the expense.

*Operating Costs: Melting and Molding*

The function of the melting department is to produce the molten metal for all castings. The elements of the cost entering into the metal cost include materials used (scrap, pig iron, etc.), labor, supplies, and a share of general expense. The cost of metal is determined on a pound basis by dividing the total cost of the melting department for a given period by the total pounds of good castings produced in that period. We follow the practice customary in other gray iron foundries of using a flat figure of cost for pricing the metal for all castings, but in highly competitive work where a greater degree of accuracy is desired in the metal cost, we determine the mold weight, that is, weight of the casting, gates, and sprue. The job is charged with the gross melt and credit is allowed at scrap value for the return. The yield method for determining metal cost gives better results in the pricing of some castings since the melting cost will be considerably higher on castings where the yield is low than on castings with a high yield.

In an effort to improve the efficiency of our cost procedures and to make the system applicable to individual types of molding and sizes of castings produced, the molding department has been subdivided into the following classifications or cost centers: (1) roll-over molding machines, (2) floor molding—crane floor, (3) squeezer molding, and (4) bench molding.

The use of overhead cranes, high depreciation, and repair cost of machines in some of these classifications make it imperative that different overhead rates be established for these cost centers. On the 20,000-pound capacity roll-over molding machine where the mold is filled with an apron conveyor from a five-ton capacity sand hopper, jarring and drawing of the pattern is accomplished mechanically and with a minimum of labor involved. The hourly overhead rate is, therefore, considerably higher than where the mold is rammed up on a bench by hand. The various overhead rates have been established by extending the detail of accounts so that items of indirect labor, depreciation, repair, sand, and supervision applicable to the classifications set forth are accumulated and charged against the proper subdivision.

*Core and Cleaning Departments*

In an intricate casting, the cores constitute one of the largest items of cost and a considerable amount of record-keeping is necessary to allocate the expense of the core department properly.

The core overhead is figured as a percentage of the core direct labor cost except that the expense of core materials is computed on a weight basis and charged to each order on a basis of pounds used.

To charge the individual casting with its proper share of the cleaning costs is one of the hardest problems of foundry cost accounting. This was the last department in our plant into which we carried our timekeeping procedures. For a long time the cleaning department expense was charged on a pound basis. Since it frequently requires as long to clean a 100-pound casting as that of a casting many times this weight, the pound method proved highly unsatisfactory. The timekeeping procedures in this department are now uniform with those of the other productive centers. The direct labor for chipping and grinding is recorded and overhead is added. The Wheelabrator Tumblast and Roto Blast, however, require special consideration and the cost of these operations are distributed to the castings on a weight basis.

### *Allocation of General Plant Expenses*

In all cases where it is possible to do so, overhead is applied directly to the department or division responsible for the expense. The general plant expenses, however, must be allocated to the productive departments on the most accurate basis possible. In our plants the operation of a machine shop and structural and welding shop, as well as a division manufacturing trailers, make the distribution of this expense of the greatest importance. Depreciation of buildings and equipment is allocated on the bases of actual floor space used and the value of the machinery in the productive departments. Power in some of the plants is based on meters but in others must be allocated on an estimated basis resulting from a rated horsepower study. Other items such as plant guards, medical services, and general salaries are apportioned on an estimated basis of service performed for the department or on a payroll basis. The payroll basis of distribution, except for items such as social security, medical services, etc., is used only after a study of other methods has failed to provide a sound basis.

### *Selling Expenses*

The last element of cost to be discussed in this paper is that of selling expenses. We have elected to apply this expense on a basis of the total foundry or manufacturing cost. Another method

of distributing selling expenses to job costs, used by some gray iron foundries but not considered appropriate for our use, is that of distribution to the productive departments and inclusion in the overhead rate of the department or cost center. Some foundries charge a rate per pound for this expense. The wide variety of products manufactured in our plants, many of which are transferred to other divisions, makes uniform treatment of this expense impossible. Some of these products are sold by the company itself through direct sales contact. Others are sold through branch offices and warehouses which we operate. Still others are marketed through distributors or dealers. In the classification of accounts, these several divisions of sales effort are set forth and each product is classified and charged with the sales expense of its own organization.

The methods of determining cost may vary in different divisions. However, the fundamentals are the same in all. In our machine shop, which has been mentioned briefly, our costs are determined on an hourly machine rate. The cost of the casting, as produced in the foundry, combined with the hourly machine rate used in the machining operations, gives the management of this company accurate cost records from the time the raw materials enter our plant until delivery is made of the finished product.

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## COMING ARTICLES

In the *N. A. C. A. Bulletin* for April 1, 1948

**Budgetary Control of Production and Costs in the Machine Tool Industry**
by Norman T. Harrison

**Basic Steps in Developing a Distribution Cost System**
by Fred L. Heath

**A Post-Sale Record for Manufactured Equipment**
by Russell I. Johnson

**Payroll Analysis for Labor Cost Control**
by Gloyd A. Harlow

# BASES OF COST DISTRIBUTION IN A MALLEABLE AND GRAY IRON FOUNDRY

by PERCY J. ESLING,
Cost Supervisor, Malleable & Gray Iron Div.,
Detroit Brass & Malleable Works, Wyandotte, Mich.

HERETOFORE, the foundry industry in its approach to cost problems has been content with costs and cost procedures tending to produce historical and comparative job or pattern costs that can be used primarily as a basis for pricing. This much was forced upon most of us due mainly to the fact that large buyers of castings demanded a competitive *part* price, thereby displacing the average price for *pound* system of the old era. During the war years ceiling prices of new castings were determined from the cost formula and profit margins in effect in the particular concern in October, 1941. The result was: good formula, good prices; bad formula, bad prices. Unsatisfactory pricing for many of the "slow starters" in the cost field created an immediate post-war stimulus for revised procedure and better methods.

In addition there is, at least in the malleable iron group, a crystallization of thought regarding control of future operations and of part costs by keeping them in line with predetermined standards. Because cost control is effective only as the various factors that make up a complete whole are controlled and because historical costs are valueless for this purpose unless they can be analyzed, it is essential that there be a proper grouping of costs to departments, operation, or cost centers and a reasonable breakdown of all expense to such centers. For this reason and as a necessary preliminary to more far-reaching objectives, this article approaches foundry costing from the more elemental but basic problem of expense distribution.

### *Objectives of Foundry Costing*

Before any detailed consideration can be given to this project in any particular foundry, it is necessary that a general plan be laid out for each plant. Many companies produce more than one foundry product and are faced with the necessity for proper distribution or allocation of plant costs to their respective product lines. This must be done before distribution can be made to individual casting costs. In general and to meet competitive business

conditions properly, the accuracy of expense distribution to product lines must be such that it will produce, for each product, a cost comparable with:

1. The cost of the same product in a period when the plant facilities are devoted exclusively to the manufacture of that product.
2. Competitors' costs of this product.

Underselling through undercosting of one line at the expense of another is a dangerous practice that may jeopardize not only the reputation of the company but of the cost man as well. The accountant must bear in mind that a mistake in judgment here will produce inaccurate and misleading job costs farther down the line.

*Heavy Materials, High Labor Costs*

Another thing that looms up in our preliminary survey is the general character of the foundry industry. There are two rocks over which our waves of cost will break. First, it is a heavy goods industry. In any foundryman's language that spells "tonnage." Someone has said that eighty-three tons of iron, sand, scrap, coal, etc., are handled to produce one ton of shippable castings. Whether this statement is right or wrong, weight must be reckoned with and costs incurred in the handling and transporting of heavy materials should follow that factor. However, before we fall into the old bog and attribute everything to tonnage, let us examine our second industry characteristic. Even with present mechanization, we have an industry in which the labor cost of the product is a high percentage of its total cost. Thus, many elements and factors of cost will be related to the unit of labor cost.

With two principal bases on which to spread costs, care must be exercised in order that a proper balance be established. An illustration using conditions in one of our plants may serve as an example. In the plant in question, we have made three distinct lines of product: (1) malleable iron pipe fittings, (2) malleable jobbing castings, (3) gray iron fittings (steam, drainage, etc.). Each successive group was composed, on the average, of the heavier type of castings and all three lines have flowed concurrently through a number of the operating departments. Yet they differ markedly. While the gray iron fittings are the heavier items, they require considerably less applied labor because of a greater

yield, smaller gates to be removed, and other causes. The reverse is true of the malleable fittings line. Too many expense items applied on a weight basis would overcost the gray fittings and perhaps price us out of the market on that work. We might secure additional business in malleable fittings only to find that we could not produce them within our anticipated costs, when the heavier gray iron line, properly carrying a fair amount of expense on a weight basis, was gone or seriously reduced. This same sort of bad costing would likewise affect individual pattern costs in the light and heavy ends of the same product line.

*Distribution of Costs to Departments*

In general the costs of trucking, transporting, shoveling, weighing, shipping, or like operations (where the nature of the individual casting is not considered) will follow the weight (tonnage) factor. Other expense will be definitely related to labor and should follow either the direct labor or the total operating labor cost.

Departmentalization of cost is a "must," principally for the reason that products, or castings, do not always pass through all of the departments or processes of the plant. They must, therefore, pick up the costs of the operations that they receive. These departmental or process costs must be complete and include appropriate portions of the general plant burden in order that each product or casting will accumulate its complete manufacturing cost. The departmentalization of the industry, which departmental cost analysis must follow, is pretty well established and a representative grouping is an incidental feature of Exhibit 1. Some expansion or contraction of this list will be necessary for most plants.

A major purpose of Exhibit 1 is to present a fairly simple and workable plan of distributing operating and administrative overhead to the operating department costs. Remembering that these are chiefly instances in which weight does not apply, it may be of interest to recite the bases on which distribution of the various categories is made:

1. *Expenses following workers' earnings* (lines 13-20) are distributed to the operating departments on the basis of the operating department labor in columns (b) and (c).
2. *General maintenance* (line 23) is distributed on the basis of the operating department repair labor in column (g),

MONTHLY BURDEN DISTRIBUTION.

| Department | (a) Material Direct | (b) Labor Direct | (c) Labor Indirect | (d) Operating Expense Supplies & Exp. | (e) Exp. to W.Average | (f) Repairs & Maintenance Material | (g) Repairs & Maintenance Labor | (h) Repairs & Maintenance General Maintenance | (i) General Overhead Power, H. Light | (j) General Overhead General Expense | (k) Fixed Charges Dep. Ins. Taxes | (l) Fixed Charges Admin. Salaries | (m) Total Manufg. Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Metal & Melting | 10,000.00 | | 1,850.00 | 3,000.00 | 822.13 | 420.00 | 130.00 | 87.96 | 580.00 | 736.81 | 848.95 | 105.17 | 18,178.74 |
| 2. Molding | | 6,900.00 | 3,350.00 | 510.00 | 1,148.80 | 1,350.00 | 850.00 | 444.22 | 730.00 | 1,300.36 | 1,536.00 | 582.98 | 21,001.70 |
| 3. Shrinking | | 2,300.00 | 1,200.00 | 1,600.00 | 1,345.75 | 550.00 | 610.00 | 318.79 | 110.00 | 507.50 | 136.50 | 227.50 | 9,406.04 |
| 4. Sprueing & Inspection | | | 1,850.00 | 10.00 | 682.12 | 10.00 | 20.00 | 10.45 | 20.00 | 234.61 | 149.40 | 105.17 | 3,025.75 |
| 5. Annealing | | | 1,300.00 | 1,250.00 | 437.56 | 600.00 | 120.00 | 62.71 | 250.00 | 165.01 | 390.50 | 73.97 | 4,749.75 |
| 6. Cleaning | | | 450.00 | 280.00 | 151.49 | 410.00 | 110.00 | 57.49 | 280.00 | 57.13 | 61.00 | 25.61 | 1,762.72 |
| 7. Gate Removal | | 1,100.00 | 600.00 | 80.00 | 572.14 | 180.00 | 50.00 | 26.13 | 130.00 | 215.76 | 94.00 | 96.78 | 3,144.75 |
| 8. Finishing | | 460.00 | 30.00 | 10.00 | 171.49 | 30.00 | 90.00 | 47.04 | 30.00 | 64.67 | 70.00 | 28.99 | 1,052.19 |
| 9. Inspect & Ship | | | 950.00 | 60.00 | 339.13 | 20.00 | 10.00 | 5.23 | — | 120.35 | 129.70 | 53.95 | 1,668.36 |
| 10. TOTALS - | 10,000.00 | 10,660.00 | 12,280.00 | 7,120.00 | 7,690.00 | 3,570.00 | 1,990.00 | 1,060.00 | 2,110.00 | 3,900.00 | 3,470.00 | 1,300.00 | 83,990.00 |
| 12. Expense Following Workers' Earnings | | | | | | | | | | | | | |
| 13. Workmen's Compensation | | | | 1,000.00 | 1,000.00* | | | | | | | | .00 |
| 14. Group Insurance | | | | 150.00 | 150.00* | | | | | | | | .00 |
| 15. Old Age Benefit | | | | 410.00 | 410.00* | | | | | | | | .00 |
| 16. Unemployment Insurance | | | | 710.00 | 710.00* | | | | | | | | .00 |
| 17. Vacation Pay (Plant) | | | | 1,050.00 | 1,050.00* | | | | | | | | .00 |
| 18. Holiday Pay " | | | | 320.00 | 320.00* | | | | | | | | .00 |
| 19. Allowances & Overtime | | | 1,670.00 | | 1,670.00* | | | | | | | | .00 |
| 20. Supervision & Clerical | | | 2,350.00 | | 2,350.00* | | | | | | | | .00 |
| 22. Operating Overhead | | | | | | | | | | | | | |
| 23. General Maintenance | | | 710.00 | | | 80.00 | 250.00 | 1,060.00* | | | | | .00 |
| 24. Power, Heat & Light | | | | 1,470.00 | | 410.00 | 230.00 | | 2,110.00* | | | | .00 |
| 25. Pattern Shop | | | 500.00 | 50.00 | | 20.00 | 10.00 | | | 580.00* | | | .00 |
| 26. General Stores | | | 260.00 | | | | | | | 260.00* | | | .00 |
| 27. General Plant Expense | | | 1,070.00 | 510.00 | | 270.00 | 150.00 | | | 2,060.00* | | | .00 |
| 29. Administrative Overhead | | | | | | | | | | | | | |
| 30. Depreciation | | | | 1,900.00 | | | | | | | 1,900.00* | | .00 |
| 31. Insurance | | | | 400.00 | | | | | | | 400.00* | | .00 |
| 32. Taxes | | | | 910.00 | | | | | | | 910.00* | | .00 |
| 33. Admin. Salaries * | | | 1,300.00 | | | | | | | | | 1,300.00* | .00 |
| 34. TOTALS - | | | 7,990.00 | 6,920.00 | 7,690.00* | 780.00 | 670.00 | 1,060.00* | 2,110.00* | 2,900.00* | 3,210.00* | 1,300.00* | .00 |
| 35. TOTALS - | 10,000.00 | 10,660.00 | 20,060.00 | 14,040.00 | ✓ | 4,350.00 | 2,660.00 | ✓ | - | ✓ | ✓ | ✓ | 83,990.00 |

* Indicates credit entry.

EXHIBIT 1.

assuming that repair labor has been departmentalized from the payroll distribution.

3. *Power, heat, and light* (line 24) are distributed on the basis of metered power, horsepower hours of operation, or some other such breakdown that is considered equitable.
4. *General expense* (lines 25-27) can be distributed either on the basis of total operating labor or the tonnage handled in each department, if that is preferable.
5. *Depreciation, insurance, and taxes* (lines 30-32) should be apportioned on relative building and equipment values.
6. *Administrative salaries* (line 33) will follow departmental operating labor.

Column (m) of the exhibit gives an operating department breakdown of the total manufacturing expense for the period, and the several columns afford a departmental breakdown of the principal over-all costs. It would be possible to analyze and regroup the expense items into variable (or controllable), semivariable, and fixed costs.

*Distribution of Costs to Lines or Patterns*

The upper portion of Exhibit 1 is the underlying work sheet for further distribution of departmental costs to product lines or individual patterns. Metal and melting costs can all be allocated to products on the basis of the weight of metal poured into customers' molds. Molding direct labor (which may include shifting, knock-off, carry-out, and pouring) is chargeable direct to jobs. Indirect labor and operating supplies will be allocated on the basis of the weight of metal poured into molds, the sand weight of the molds, or a combination of these. The items of repairs, operating overhead, and fixed charges are perhaps more equitably distributed on direct labor cost than on tonnage. Coremaking costs are more nearly related to the weight of cores used than to any other factor and it is good practice to distribute all coremaking expense (apart from the direct labor) on that basis.

Sprueing and inspection (when not direct charges) can be distributed on the weight of good castings poured. Annealing costs will follow the tonnage annealed (including reannealed castings) and cleaning costs will follow the weight of castings cleaned (including those recleaned). Gate removal direct labor, consisting

of grinding, shearing, milling, etc., will be applied directly to products or jobs. Indirect labor and operating supplies should follow the tons processed in that department and the balance of the items should be applied on the basis of the direct labor cost.

Finishing direct labor will include such items as straightening, gauging, chipping, water testing, etc. Indirect labor and operating supplies will follow the finished casting tonnage and the other items the direct labor cost. Inspection and shipping (when not applied directly to products or jobs) can be distributed on the basis of the finished casting weight or the shipped casting weight if the products are stocked before shipping.

In all of the above, where the direct and indirect labor are distributed on different bases, the expense following workers' earnings will be applied as a percentage of the combined direct and indirect labor.

*Selling and Administration Expense*

In this way all of the manufacturing expense is taken care of. The costs of sales and administration remain to be considered. These are best applied to the product or job on the basis of the dollars of manufacturing cost. In cases of allocation to product lines, when one product may be shipped from stock in a period during which it was not produced, selling expense can be applied on the basis of the dollar "cost of sales" and the administrative expense on the dollar of manufacturing cost.

The purpose of the above has been to set forth very briefly, in somewhat basic outline, the distribution problem of the foundry industry. It is not necessarily a solution to the problem of everyone concerned. It is hoped that this paper may have brought into view some of the obstacles to better foundry costing so that we can analyze, study, and arrange the cost elements in patterns that will meet the requirements of our postwar world.

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## *DIRECT MATERIAL COSTS OF CASTINGS*

Since castings of various sizes, shapes, designs, etc., will cause marked fluctuations in the per cent of yield and hence in the consumption of direct materials, many cost accountants engaged in foundry practice will analyze material costs as to the elements of price, volume, and then per cent of yield. In setting foundry standards for material consumption, the factors of price and quantity are considered in relationship to volume of production at standard yields. (*Frank J. Frech, Rockford*)

# PRODUCTION CONTROL AND COST PROCEDURES IN A FOUNDRY PRODUCING STANDARD UNITS

by H. LEON ABERNATHY, Chief Accountant,
Chattanooga Implement & Mfg. Co.,
Chattanooga, Tenn.

AS I THINK about foundry costs, the number one problem is how to get the information out of the foundry and into the accounting department. Once the correct information is in the office I do not think any of us will have very much trouble in compiling it, but our real trouble lies in establishing a method and then in getting this method or system carried out or followed in the plant. Of the various cost elements involved in foundry accounting, namely labor, materials, overhead, and flow of production, I recognize production as being the most difficult to deal with.

### *Production Control*

Therefore my first thoughts are concerned with production and how to control it through proper cost information and facts. The basic requirements for control are: (1) a plan or budget of controlled production and (2) a means of recording production after the production plan has been put into operation to ascertain whether requirements are being met as scheduled.

Since we produce a standard line of goods (that is, our end products are catalogued) we look to top management and the sales department to give us what we call a "factory order" for goods that can be reasonably expected to be sold during the current season. This is based on the market trend, past records, and just general discussion. These requirements are subject to change from time to time but the changes are usually few and limited in amount. You may call this "factory order," if you wish, a budget for expected sales broken down in complete detail.

After the "factory order" has been prepared the production department takes over. The order is further broken down into the necessary component parts to produce the finished product and these parts are then applied to the plant capacity and the following questions asked: When do we want them? How many patterns do we have? How many flasks do we have? Which of our molders are qualified to produce these parts?

*Production Orders*

At this point the production order we have designed for the foundry comes into existence (Exhibit 1). A number of these orders can now be issued and given to the foundry office, with production scheduled in any way desired. The production order calls for a certain number of units to be produced at *so many per day* and once an order is put into process the following information is posted on the form each day:

1. Date of production.
2. Employee's clock number.
3. Daily production.
4. Discounts and breakage, broken down into several classes.
5. Balance to be produced at the end of the day.

The orders are filed in a large four-ring binder properly indexed so that the foundry foreman can refer to them at any time. The daily production column enables the foreman to determine whether or not the production is agreeing reasonably with the daily requirements. The foreman can tell at a glance, by checking the discounts being reported on an item, how many more units are needed to finish the order, Since the daily requirements are listed at the top of the order, the number of days necessary to complete the order can be ascertained by comparing the daily production column with the last column, balance to produce. Likewise the foreman is in position to stop production on a given order and schedule another order promptly, avoiding delay in production resulting from failure to assemble tools for a new order in time.

PRODUCTION ORDER

Date order was issued ..... Article .....

Department ..... % on board .... Daily production requirements .....

Job No. ..... Sheet No. ..... Total units on this order .....

| *Date* | *Employee's Clock No.* | *Daily Production* | *Discount and Breakage* | | | | | *Balance to Produce* |
|---|---|---|---|---|---|---|---|---|
| | | | *Gang-way* | | *Mill Room* | | *Factory* | |
| | | | *Emp.* | *Co.* | *Emp.* | *Co.* | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

EXHIBIT 1

As stated above, all production, discounts, and breakage information is posted to the production orders each day by a clerk in the factory office and this clerk can also furnish the accounting department with information taken from the orders for any period needed. This daily posting keeps the production information current at all times.

*Gathering Control Data*

We have now explained the working of the production order but a more important consideration is: how is the information gathered and at what point is it gathered for posting? Since cost and production must be controlled at the source, we must go to the source for our information. Since our molding is done on a piecework basis, our daily employee time sheets show the number of pieces produced each day. This time sheet is called a molder's daily time sheet and the following information is shown on it:

1. Castings, name, number, and size.
2. Molds put up.
3. Units per mold.
4. Molder's discount.
5. Company's discount.
6, Total units.

The above information is listed out in the foundry each day by the molder foreman and timekeeper. It is an actual count and each man is given a copy of the time sheet so, naturally, we have one side checked by the operator as to its accuracy. If we should fail to list enough castings the operator would quickly bring this to our attention. However, we have very little check if we list too many castings.

*Material Costs*

Material costs in a gray iron foundry will not require a lengthy discussion. It is probably the easiest of the cost elements to record. As to the actual raw materials, we carry a detailed stores ledger having a separate sheet for each item. Stores ledger receipts are posted direct from the supplier's invoices and the issues are posted from our regular stock room requisitions. In case of the cupola, materials are posted from a daily cupola report showing the total materials used in the cupola each day. This stock ledger shows our raw materials inventory for any accounting period both as to quantity and value.

From this point on, our system may or may not be similar to other systems. We cost our materials and labor in groups. By that, I mean that our material cost is grouped as to *cupola cost, core cost, foundry cost,* etc. The cupola cost, figured on a cost per pound of good castings, is the cost of pig iron, scrap, coke, limestone, and flux dumped in the cupola resulting in melted iron. This cost divided by the good castings received is the cupola cost per pound of good castings. The core room cost is the cost of core sand, oil, wire, core binder, and other materials used for the making of cores. The entire material cost for this department divided by the pounds of good cored castings received gives us a cost per pound for cored materials.

Additional material costs in the foundry itself are very small in dollars but cover a broad range of items. This is the cost of all sand, parting, hinge tubes, chaplets, etc., used principally by the molder in making the molds. The cost of all these materials divided by the total pounds of good castings received gives us the foundry material cost per pound. The same principle applies to the grinding room where mill-stars, grit, and cleaning materials are added for the purpose of cleaning and grinding the castings. With this information we are able to present management with a report showing the dollar cost and cost rate of materials used for the different departments above.

*Labor Costs*

From general information on hand, it seems that the foundry industry recommends an over-all per pound labor cost for the entire foundry and all products. At the beginning of our foundry cost efforts, we adopted this over-all foundry cost basis and divided the total good castings received into the total labor for the foundry. We did, however, break our labor down to operations, thereby giving a labor rate for each operation. All casting carried the same rate within these operations. This method of applying labor produced difficulties and brought criticism in our case. The sales department pointed out that it could not meet competition on common work, whereas our costs seemed to be under the market on castings that were more difficult to produce or had to go through a finishing process.

Since our over-all labor cost was not satisfactory, we dropped it and adopted a method to show a complete detailed molding labor cost for each item produced. This was accomplished by

assigning a job number to each part and producing this part as a separate item, thereby arriving at the molding labor cost of each part separately. This was a highly detailed method requiring several hundred job numbers. The possibility of error was great. The method was carried along for one year and discarded for the present method currently used as described in the next paragraph.

To carry out our present method we have assigned a job and operation number to the melting of all irons. For labor, we have grouped our molding into about nineteen classifications, assigning a job number to each of these classes, and we record our labor accordingly. The detail of this system is carried out through our daily time sheets. The timekeeper is required to record the job number corresponding with the items he has listed on the time sheet. These numbers are checked in the office and since the total classification does not cover over twenty-five job numbers for the entire foundry, the labor distribution arrived at is believed to be reasonably accurate, By this method we are also able to obtain a molding cost per pound for each of these groups.

### *Importance of Discount in Foundry Operations*

Foundries are well-known for the percentage of discount they have to absorb. This is especially true if the castings are small, and still costly if the castings are large. In any foundry, the amount of discount allowed can put a certain product in the red or pull it over in the black. Even if the molding is on a piecework basis, only a small part of the casting cost can be charged back to the operator. The cost of melting iron, making a core, and many other charges will have to be absorbed. From the production order, a summary of the discounts for the month can be tabulated and compared with the production on the same sheet for the month. This ready information is especially helpful to the foreman, as he sees the discount before the report is made. The discount and breakage report has resulted in immediate changes which have eliminated some or all of the trouble.

### *More Than One Cost Sometimes Needed*

Very often cost information for one purpose will not give information, or at least the best information, for another purpose. In preparing reports for management in an effort to show foundry costs, we would prefer to give only one labor cost per pound or one material cost per pound or one overhead cost per pound.

We would prefer to show melting costs at so much per hundredweight and the same for molding costs. It is much easier to visualize the costs in this manner than to try to use several rates. However, if there is a very great variation between the cost of different periods, the cost will have to be broken down to the castings in order to arrive at useful figures and if the individual cost of certain items is desired, it would be necessary to use the rate applicable to the class of castings of which this item is made.

Our method of costing might not work in a job shop for, in producing castings on a job basis, each job would have to be given a job number and the number would live and die with the order. Our order numbers are perpetual and each new order carries the job number applicable to that particular type of job. These numbers carry through from month to month or even year to year. We add a new job number only when castings are added that do not coincide with castings already being produced.

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## *THE CHALLENGE OF BUDGETING*

In these days the student accountant finds the accounting field offering specialties such as general accounting, auditing, or cost accounting and its subdivisions. Cost accounting, I think, holds the greatest attraction and to my mind, no phase of cost accounting offers more interest than budgets. All other phases of the accounting art concern themselves with that which has passed into history or that which is presently transpiring. Budgets by contrast involve a forecast of operations to take place in the near future. They are concerned with operations to come and therefore present a challenge to the accountant that no mere concern over past history can approach.

First, budgeting calls upon his ability to collect facts on past performances. Secondly, it requires him to sift these facts, to analyze them, and then to present them in a lucid manner. The third step, that of interpreting the facts into a forecast, links the accountant to the dynamic end of the business, the planning section of the business, and gives him an important role in plotting the course of the enterprise. (*F. C. Dunlop, Des Moines*)

# DETERMINING COSTS BY CUSTOMERS IN A MULTI-METAL JOBBING FOUNDRY

by BETTY GAY WISE,
Cost Department Supervisor,
Waukesha Foundry Co., Waukesha, Wis.

IN A JOBBING FOUNDRY the cost accountant is constantly striving for the theoretically ideal situation in which the cost and price of each and every job would be established so that every *job* would stand on its own, cost and profit-wise. However, under competitive conditions, it is often necessary for a jobbing foundry to accept a heterogeneous group of patterns from a customer and to arrive at a price for each of his jobs with considerable variation in the cost and profit factors and their relationship. Therefore, for cost control in a jobbing foundry, it is advantageous to know the over-all cost and profit picture for each *customer* account without reference to particular jobs. The following is an explanation of a simple customer analysis system which we have worked out to give us this over-all customer account control monthly.

### *Basis of Grouping and Distribution*

In our foundries, we manufacture casting in four general classifications of metals—aluminum, brass, nickel alloys, and stainless steel—and all operating costs are broken down into these four general manufacturing classifications. Exhibit 1 shows the results of foundry operations in aluminum castings conducted for the (hypothetical) Brown Manufacturing Company. The following steps in preparing customer cost summaries on a monthly basis result in similar figures for each customer and class of castings:

1. *Shipments* are recorded by customer under the metal groupings and are further segregated by alloys for a more accurate metal cost determination.
2. *Inventory increases or decreases* in jobs in progress for each customer, classified by metal groupings, are determined.
3. *Equivalent of production* for the period for each customer account under the general metal classifications is determined by adjusting shipments by the sales value of the change in inventories.

CUSTOMER PROFIT AND LOSS ANALYSIS

(All figures and names are hypothetical)

*Customer—Brown Manufacturing Company*

Aluminum Castings

November 1947

| | | | |
|---|---|---|---|
| Shipments—November | | 31,760 pounds<br>$16,095.91 | |
| Inventory adjustment (decrease) | | — 2,627 pounds<br>—$ 2,021.08 | |
| Equivalent production | | 29,133 pounds<br>$14,074.83 | |
| Melting cost (standard rate per lb.) | $ 582.66 | | |
| Direct molding labor (job tickets) | 1,482.40 | | |
| Molding overhead (standard rate) | 1,853.00 | | |
| Direct core labor (job tickets) | 595.20 | | |
| Core overhead (standard rate) | 833.28 | | |
| Direct cleaning labor (job tickets) | 687.80 | | |
| Cleaning overhead (standard rate) | 1,238.04 | | |
| Total | 7,272.38 | | |
| Scrap (standard allowance) | 363.62 | | |
| Total | 7,636.00 | | |
| General and administrative (standard) | 1,069.04 | | |
| Metal cost (market price including shrinkage factor) | 4,282.55 | | |
| Freight (including handling standard) | 196.91 | | |
| Other charges (heat treating, including handling standard) | 219.65 | | |
| Cost of production | | | 13,404.15 |
| Profit (or loss) | | | 670.68 |
| Per cent profit (or loss) | | | 4.76% |

EXHIBIT 1

4. *Melting costs* are based on our standard melting cost factor for each general metal classification.
5. *All direct labor* costs in the molding, core, and cleaning departments are accumulated mechanically from the job ticket. These job tickets are turned in daily to the cost department, indicate the general metal classification, and are filed by customer.
6. *Standard rates* of departmental overhead and scrap are used in computing the cost of production figure.
7. *Metal cost* is determined by applying the standard shrinkage factor to the current market price of the metal consumed (equivalent production figure).
8. *Freight charges* are calculated from actual freight rates plus a standard overhead factor covering shipping and handling costs.

9. *Other charges* such as heat treating and normalizing are included at the actual cost charged to the foundry division plus a standard handling and overhead factor.

10. *The total* of all of factors 4 to 9 gives a cost of production figure for each customer which is a composite of actual and standard cost factors.

11. *Small shipments* are grouped together in a "miscellaneous" account in each general metal classification to expedite calculation work.

### *Tie-in with the Accounts*

Any difference between cost of production figures obtained by such an analysis and the actual profit and loss figures of the plant as a whole is directly attributable to the variance from standards and can be quickly spotted. The results of the customer analyses prepared each month are carried to a Customer Production and Profit and Loss Summary (Exhibit 2) which serves as a ready reference covering a period of time. Both the analyses and the summary have been of vital aid to us in customer relations in connection with price adjustments and have aided the cost department by clearly indicating the phases of work requiring concentration along with general over-all control.

CUSTOMER PRODUCTION AND PROFIT AND LOSS SUMMARY

Customer: Brown Manufacturing Company

Metal: Aluminum

| | Production | | Profit or Loss | | Remarks |
|---|---|---|---|---|---|
| 1947 | Pounds | Value | Dollars | Per cent | |
| October | | | | | |
| November | 29133 | $14074.83 | $670.68 | 4.7% | |
| December | | | | | |
| 1948 | | | | | |
| January | | | | | |
| February | | | | | |
| March | | | | | |
| April | | | | | |

EXHIBIT 2.

# N.A.C.A. BULLETIN

*Section Three*

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RESEARCH SERIES NO. 12

## STANDARDS TO AID CONTROL OF MANUFACTURING COSTS

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VOL. XXIX, NO. 14 MARCH 15, 1948

## FOREWORD

This study, which is the second in a series dealing with standard costs, presents the results of a field study designed to show how standard costs are used to aid in the control of manufacturing costs. It follows "A Reexamination of Standard Costs" published in the *N.A.C.A. Bulletin* for February 1, 1948. The first study took a broad view of the entire field of standard costs and therefore omitted details which are of interest to those who are faced with the practical application of standard costs. Actual procedures which management can use to facilitate its efforts to control costs are described here. Succeeding studies will describe practice in the use of standard costs for inventory costing, budgeting, and pricing. A final study will then show how these various uses for standard costs can be coordinated.

In the field survey 72 companies employing standard costs were visited by members of the Research Staff. Each company's procedures were recorded and the underlying reasons were discussed. The following industries were represented in the study:

| *Principal products* | *No. of companies* |
|---|---|
| Metal products (wire, hand tools, stampings, etc.) | 15 |
| Textiles | 12 |
| Machinery | 8 |
| Paper and paper products | 6 |
| Electrical equipment | 5 |
| Rubber goods | 5 |
| Measuring and weighing devices | 3 |
| Nonferrous metals and fabricated products | 3 |
| Building materials | 2 |
| Chemicals | 2 |
| Pencils and pens | 2 |
| Watches and watch cases | 2 |
| Photographic and optical equipment | 2 |
| Miscellaneous other (clothing, shoes, cosmetics, etc.) | 5 |
| | 72 |

While most of these companies are located in the northeastern states, a few companies in other parts of the country contributed to the study. A review was also made of the many standard cost case studies which have been submitted for publication in the *N.A.C.A. Bulletin* over a period of years.

In summarizing the information, emphasis has been placed upon the main trends and listing of many exceptions has been avoided. It is hoped that a clear picture has been obtained by this approach.

I. Wayne Keller, *Chairman,*
*Committee on Research.*

# STANDARDS TO AID CONTROL OF MANUFACTURING COSTS

COSTS of production are affected by internal factors over which management has a large degree of control and also by external factors over which management has only limited control. One of the first steps in the development of a plan for cost control is the separation, as far as possible, of noncontrollable factors from those factors which are controllable. In this respect standards are valuable aids. Since the scope of managerial control over material usage, labor performance, and overhead spending is more direct than it is over prices paid and production volume, the main emphasis of this paper will be on standards for the cost factors first named.

Control over costs is best effected through action at the source. Hence the standards used need to be specifications for the quantities of material, labor, and services to be consumed in performing an operation rather than the complete product cost standards. Variances from these standards should be developed to show causes and responsibilities for deviations from standards. Corrective action to eliminate variance causes lies in the field of management, but operating management relies on the accountant for facts which make possible intelligent executive action toward control of costs.

## Material Quantity Standards

Material quantity standards are based upon the standard bill of materials which, in turn, is developed from the product specifications. The material quantity standards thus tell what kind and what quantity of material should be used to make the product desired. These physical quantity standards are the primary basis for material cost control; they are converted to cost standards by multiplying the standard quantities by unit material price standards for the purpose of measuring material cost variance.

### *Setting Material Quantity Standards*

There are three methods in use to set material quantity standards. These may be described as follows:

1. Engineering studies to determine the best kind of material for the purpose and the proper quantity to use.

This requires a consideration of the production methods to be used, quality of the product to be made, expected yield, and similar factors.

2. Analysis of past experience in usage of materials for the same or similar products. In setting standards by this method past performance is averaged or the standards are based on jobs or periods which are selected as typical. The use of unadjusted past experience may include in the standards an undetermined amount of past waste and excess usage. Known excess usage may be eliminated in setting the standards or the standards may be tightened by an arbitrary percentage reduction in the quantity of material allowed, but the method does not focus attention on finding the best combination of quantity, methods, and product quality as does the engineering study method. However, the use of past experience may be less costly and quite satisfactory in setting standards for minor items of cost or perhaps for obtaining temporary standards.[1]

3. Test runs under controlled conditions. This method avoids some of the principal shortcomings of the preceding method in that conditions can be standardized and extraneous causes of variation eliminated. Most companies use a combination of the above methods in setting their material quantity standards, although approximately two-thirds of the companies interviewed reported that they rely principally on engineering studies.

### *Allowances Incorporated in Material Quantity Standards*

When material quantity standards are set by engineering study, the calculation of standard quantities from drawings and product specifications yields theoretical or ideal quantity standards to which allowances must be added to get the attainable standards needed

[1] As stated in the accounting manual of one company, "The ultimate effectiveness of procedures will be determined by ability to set good performance standards. Where such standards cannot be set with a high degree of accuracy at the outset, much can still be accomplished by setting approximate standards. . . . The variances resulting from measurement of actual expenditures to standard may not be 100% controllable, but by segregating them in such a way that they can be analyzed, it will be possible to obtain factual data upon which to base more accurate standards in the future and thereby set up a more effective control of manufacturing costs."

for control. While the allowances that are made depend partly upon the nature of the production processes, nearly all of the companies interviewed increase the quantities of material included in the standards to cover a certain amount of wastage and loss that is considered impossible or impracticable of elimination. Thus in metal working there are turnings, chips, and butt ends cut off; in chemical processes losses occur by leakage, evaporation, etc. A company manufacturing asphalt roofing states its procedure for setting standard material quantities as follows:

> "The laboratory determines what materials and quantities will be needed to make the product wanted. This is an ideal standard. Following this a processing loss allowance based on experience is added to get the standard usage. Included in the allowance are such items as leakage of asphalt, evaporation losses, damaged ends of felt rolls, trimmings, etc."

In addition to the above, approximately half of the companies include an allowance in the standard quantity to cover direct materials spoiled in processing.

Material losses in manufacturing may be kept apart from rather than included in the material quantity standards.[2] A separate cost standard is then established for such losses. In some cases this is treated as a separate cost item, but usually it is included in the overhead budget.

### *Tightness of Quantity Standards*

Approximately two-thirds of the companies interviewed reported that their material quantity variance accounts occasionally show favorable balances at the end of a month whereas the other one-third stated that their net material quantity variance is seldom or never favorable. While the absence of favorable variances may be an indication of tight standards, favorable variances may arise from changes in factors not completely controlled or allowed for in the standards. Thus several companies reported that they could not change their standards as often as changes occur in production methods or product specifications and hence favorable quantity

[2] For example, the standard cost manual of a manufacturer of electrical equipment states that: "Our product costs are set up on the basis of using exact quantities per unit as prescribed in the bill of materials. Since exact quantities cannot be adhered to, even under the best of manufacturing operations, a standard spoilage allowance is provided for in the standard product cost sheet."

variances occur when these changes reduce the quantity of material actually used below that allowed by the standards. In addition, conditions which affect yield from materials cannot always be entirely controlled and standards are set for average performance thus making favorable variances possible. Examples here are the effect of humidity on textiles or the lack of uniformity in raw materials like leather or cork.

On the other hand, favorable variances may occur because standards are loose and easily exceeded by performance. It is interesting to note that in six cases it was stated that occurrence of favorable variances was viewed as an indication that standards had been set too loosely.

*Effect of Conditions of Supply*

Setting of material standards and the use of these standards for cost control is made difficult when conditions of material supply make it necessary to use substitutes or to accept materials which do not meet standard specifications. Scrap losses, reoperations, and rejected product are thus likely to be large and difficult to predict. Setting the standards loose enough to cover all of these items tends to weaken the control value of the standards, while tight standards result in large variances for which operating personnel cannot be considered responsible. The prevailing opinion seems to be that the best procedure is to maintain tight control standards and then to make an analysis of variances as to cause, with such extra allowances or separation of noncontrollable items as is possible before assessing responsibility on operating personnel.

*Frequency of Revision*

Since material quantity standards are based on product specifications and production methods it might be expected that changes in the standards would accompany changes in these specifications. This expectation is borne out by the field study, for four-fifths of the companies interviewed revise the material quantity standards used for current cost control whenever changes in methods or products affect the kinds or quantities of material used. The remaining companies review material quantity standards periodically and make any changes which may be necessary at that time. Most of these companies review their standards annually.

Regardless of the infrequency with which standards for costing inventories are revised, it would seem necessary to make changes

in standards used for cost control whenever there are definite changes in product specifications affecting material usage if good cost control is to be maintained. It is evident that some of the companies which change their material standards infrequently make little use of these standards for cost control purposes.

*Responsibility for Setting Material Quantity Standards*

Material quantity standards are usually set by the department which is responsible for product design and for operation methods in the factory. While specific titles vary, the engineering department was mentioned most frequently as setting material quantity standards. Five of the companies interviewed have separate standards departments although some of these are under engineering supervision. In the smaller companies where a separate organization unit for the purpose of setting standards is not needed, the task of setting material quantity standards is usually delegated to an individual familiar with products and manufacturing methods.

It is common for more than one department to participate in setting material quantity standards and the production and cost departments are often mentioned as assisting. This makes it possible to utilize the knowledge and experience possessed by these departments and also helps to obtain their cooperation in making the standards effective. The production department itself rarely sets material standards since it is considered undesirable for the persons held responsible for meeting the standards to have final authority to set the standards. While the engineering department is usually a part of the production division of the business, it reports at a sufficiently high level to give it the independence needed in setting standards.

In the field study several companies reported that material quantity standards are set by their cost departments. In some of these cases the material cost standards are used primarily for bookkeeeping convenience and not for cost control purposes.

*Application of Material Quantity Standards for Cost Control*

Control of material costs is aided when each person possessing authority to use material knows in advance exactly what quantity of material he should use to obtain the desired quantity of product. Furthermore, he needs to know how successful he is in meeting the standard and it is desirable to have these facts reported to him and to those who supervise his work. These reports will be

most effective if made in time for adjustments or corrections to be made before any unfavorable tendencies can accumulate into large losses.

In the factory, this means placing detailed quantity standards for each operation or process in the hands of the foremen and reporting variances to them. Production executives with supervisory authority over the foremen are more concerned with overall results than with details, but they should also receive variance reports. Through these variance reports they are kept informed regarding performance of the foremen in controlling costs and thus they can better judge when they should take action to correct unsatisfactory conditions.

The specific procedure for matching actual usage with the corresponding standards is influenced by a number of factors, among which the following appear to be most significant:

1. The nature and value of the materials.
2. The type of accounting plan used.
3. The methods used for detecting and measuring losses of material in production.
4. The extent to which cost reports are employed by management for purposes of cost control.

These factors will be discussed in the order listed above.

1. *The nature and value of the materials.* Usage of some materials can be predetermined quite exactly and actual usage accurately accounted for. Purchased parts such as electric motors or valuable materials like gold are examples. On the other hand, usage of materials such as lumber, coal, or scrap iron is not accurately controlled because of the nature of the material or its low unit value. Usage standards for these materials represent average consumption and variances are collected as totals for a period of time.

2. *The type of accounting plan used.* Where a job order production plan is in use, the material variance is usually determined for each order. If a process plan is in use, the material usage variances are determined periodically.

3. *The methods used for detecting and measuring material losses in production.* When the production order calls for a definite quantity of product and an underrun is not permissible, the

actual quantity of material used can be compared directly with the standard quantity specified in the bill of material. A requisition or bill of materials is prepared for the standard quantity of material needed to make the number of product units called for by the production order. The workmen are thus provided with the standard quantity of materials for the job. If additional material is needed to complete the quantity of product called for by the order, excess quantity requisitions are prepared. These call attention of factory personnel to failures to meet the standard. Variance reports for executives having supervisory authority over production are prepared by periodic summaries of the excess quantity requisitions.

When the quantity to be produced is not definitely fixed, it is necessary to consider the amount of good product that should have been obtained from the actual quantity of material used. This procedure may be reversed by determining how much material should have been used for the quantity of product obtained. Variances are the result of excess scrap or substandard yield from processing resulting in less than the quantity of product called for by the order. Pricing recorded production at unit standard cost for material gives the standard material cost. The material quantity variance may be determined by comparing this figure with the standard cost of the actual quantity of materials used. Where the product is put through in lots or orders the comparison may be made at the completion of each order; where production is on a continuous process basis, comparisons are made periodically.[8] In the latter case it is necessary also to consider any materials in the work in process inventory.

A weakness of this method is that the variance is not available until some time after the losses have occurred. If details are wanted as to the causes of the variances and responsibility for them, it is necessary to analyze the variance totals and to trace them back to their sources. At this time it may be too late to stop specific losses, although action can still be taken to keep them from continuing. For this reason methods are often used for

[8] Thus a machinery manufacturer reports that in its foundry the pig iron usage variance is determined as follows: "Each shipment of pig iron is put into inventory at standard price. Daily reports of the material charged into the cupola form the basis for a monthly adjustment between actual pig iron used and the standard amount which is based upon the output of net good castings."

detecting and measuring the more important material losses at a point nearer their source. The following are typical procedures:

a. The work is inspected at designated points in the process of manufacturing. Reports of rejected work are prepared and losses of material resulting from rejections are charged to a variance account.

b. Scrap and spoiled work put aside by operators is measured and cost of any such material loss in excess of standard is charged to a variance account.

c. Yield of good pieces from each process or operation is compared with the standard yield from the amount of material used. Shortage or overage tickets are prepared and used as the basis for determining the material quantity variance.

There will usually be residual material quantity variances not detected by the above methods. However, they will be disclosed when the work in process account is cleared of the standard cost of the work. Variances which are too small to justify separate measurement can be picked up in this way.[4]

4. *The extent to which cost reports are employed by management for purposes of cost control.* Some companies rely upon physical quantity standards for detailed control of material usage, and variances in terms of cost are developed only at the end of the accounting period, usually in connection with an annual physical inventory.[5] From the control point of view, the cost variances serve principally as an over-all or summary measure of how effective the physical control has been during the year.

Several companies interviewed enter only actual material cost on the books, but for control purposes they utilize standards in terms of quantities.

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[4] A woolen mill charges the soaps, dyes, and chemicals used in scouring and stock dyeing to work in process inventories at standard cost. Variances due to usage of these materials are then determined by the differences between book inventory figures and the physical count when the semi-annual physical inventory is taken. The cost represented by such variances is relatively insignificant.

[5] Thus a wire manufacturer states that its material quantity variances are small due to close physical control by the engineering department during the production process. The company therefore determines its material cost variance only at the end of the year when a complete physical inventory is taken. However, weekly physical usage reports are prepared for foremen.

*Material Variance Analysis and Reporting*

When variance reports are used for control of material cost the reports must provide adequate detail as to sources and causes of variances. They must also help to place responsibility for the variances.[6] The field study showed that such reports are prepared by summarizing material requisitions, scrap tickets, inspection reports, or other primary records rather than by drawing off variance reports from the books. This enables the reports to be made more promptly and avoids entry on the books of details that are not needed for costing production.

The field study disclosed that variance reports generally go to all those in the company management who are directly concerned with production. These include foremen, departmental supervisors, factory superintendent, vice president in charge of production, and in several instances the president. One company supplies reports to individual machine operators.

The field study showed that a number of companies maintained material usage control by the use of quantity standards and various on-the-spot checks which keep quantities close to prescribed usage. These companies often have such close control over material usage that they find it unnecessary to prepare detailed cost variance reports. In small companies, the closeness of management to factory operations also serves to keep executives informed concerning material usage and variance reports are largely unnecessary.

*Follow-up of Material Quantity Variances*

The use of standards is ineffective in controlling costs unless some systematic procedure is employed to make sure that action will be taken when important variances arise. Approximately half of the companies interviewed reported the use of regular follow-up procedures when material variances occur. These usually consist of a discussion of the variances at regular meetings of the execu-

[6] Analyses of material quantity variances are made regularly on the following basis by 33 companies interviewed in the field study.

| | *No. of companies* |
|---|---|
| By type of material | 14 |
| By products | 10 |
| By job orders | 4 |
| By departments | 20 |
| By cause of variances | 16 |

tives concerned. At this time corrective actions may be planned, further investigations suggested, etc.[7]

Companies which reported no regular follow-up procedure to be in force were asked what managerial action would be taken if a large material quantity variance should occur. In general, the answer was that the line executive having supervisory responsibility for costs would start an investigation and follow up the matter as far as he thought necessary.

## Material Price Standards

### *Usefulness of Price Standards in Control of Material Costs*

As stated by the controller of one company visited in the field study, "Price variances are affected more by external conditions than by internal control."[8] Price standards make it possible to separate cost variances arising from excess usage and other controllable conditions from cost variances caused by changes in price paid for the materials and similar external conditions over which there may be little control. If the price standards had no other value in controlling costs it would seem necessary to have them for this purpose. However, price standards are used for measuring some aspects of purchasing performance and for measuring the over-all effects of price changes on costs and profits.

Material price standards usually represent what the actual cost of materials is expected to be instead of an efficient or desired price. Most of the companies interviewed in the field study reported that they base their material price standards on either a forecast of the actual price anticipated during the period that the standards will be in effect or on the actual price prevailing at the time the standards are set. The main problems which arise in setting material price standards relate to the use of standard costs for costing inventories and for pricing products. Hence, further discussion of how material price standards are set will be deferred to the later studies in this series.

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[7] Other procedures reported by various companies are:
Persons directly responsible for a variance are required to report on cause and steps being taken to avoid recurrence of unfavorable condition.
Cost engineer spends full time investigating variances.
Supervisor makes an investigation and orders corrective action if he thinks it necessary.

[8] This was particularly true at the time this study was made. When an adequate supply of materials is available, management should have a larger degree of control over material prices in many industries.

### *Price Standards to Control Purchasing Performance*

The purchasing department may exert some control over the cost of materials by buying in economical quantities, by taking advantage of the cheapest methods of transportation, or by approving invoices in time for payment during the discount period. Since most of the companies interviewed include freight inward in the standard material prices, it would seem that price variances arising from shipping by more expensive methods could be determined and responsibility therefor established. However, such a variance would not always be the fault of the purchasing department, for it could reflect failure of the factory to anticipate its needs, acceptance of a rush order by the sales department, or disturbance of transportation facilities by strikes, congestion, etc.

### *Other Control Uses of Material Price Standards*

Price standards are also useful in showing the effect that off-standard prices will have on profits. Top executives are responsible for maintaining a proper balance between costs, selling prices, and volume of sales. In doing this the executive needs to be kept informed regarding the effect which changes in material prices will have on costs and profits, for action can sometimes be taken to counteract unfavorable effects that changes in material prices may have on profits. Thus substitute materials may be found which are less expensive, changes in product specifications or processing methods may be made, or selling prices may be increased. Initiation of such action is largely up to the top executives. For this reason the reports on material variances which indicate the need for such action are regarded as important control reports by many companies. This can be seen in the fact that in the field study it was found that reports of material price variances are generally supplied to top executives.

### *Responsibility for Setting Material Price Standards*

In the field study it was found that material price standards are usually set by the cost department, by the purchasing department, or by the two working together.[9] While the main task of setting

[9] Following is a tabulation of replies received in the field study:

| *Material price standards set by:* | *No. of companies* |
|---|---|
| Purchasing department | 12 |
| Cost or accounting department | 24 |
| Cost department and purchasing departments together | 14 |
| Miscellaneous other departments | 12 |
| Total number of companies replying to question | 62 |

material price standards is performed in these two departments, it was frequently stated that various other departments are consulted, give advice, or supply information. However, in many cases the process of setting a price standard is largely one of assembling relevant price figures since the standard is so often based on current market levels. The purchasing and cost departments are in possession of the data concerning prices and market conditions. Hence they prepare the forecasts or select the current price figures which determine the standards.

### *Pricing Materials at Standard*

In the field study it was found that three-fourths of the companies price materials at standard when the materials are received. The remaining seventeen companies apply the standard price at some subsequent point, usually at the time materials are issued. Companies in the latter group ordinarily make little attempt to use variances for control of material price since the variances are not known until some time after the materials have been purchased.

### *Material Price Variance Reports*

Most of the companies prepare monthly reports showing variances from price standards.[10] These reports usually go to top executives (president, vice-presidents, treasurer, and controller), to the purchasing department, and less frequently to the production department.

In a majority of the companies price variances are shown on a formal report. In some instances these reports are limited to a statement of price variances, but more often the price variances are listed along with the other manufacturing cost variances on a special variance report or on the statement of cost of goods manufactured. Reports confined to price variance information generally list materials classified by types of commodities and give the actual

[10] The tabulation below indicates the frequency with which these variances are reported by 62 companies which replied to the question.

| | *No. of companies* |
|---|---|
| Quarterly | 3 |
| Monthly | 43 |
| Weekly | 2 |
| Irregularly | 2 |
| | 50 |

The remaining 12 companies do not show price variances on any reports.

cost, the standard cost, and the variance for each class of material.[11]

Companies not showing price variances on a formal report bring significant variances to the attention of those concerned by such means as oral presentation, by having the persons responsible examine various records (e.g., invoices on which extensions at standard prices have been made, journal entries summarizing material costs, etc.), or by occasional preparation of memos. Usually these companies are small or purchases are few in number.

### *Responsibility for Material Price Variances*

To the extent that responsibility can be placed for material price variances, this responsibility generally is stated to rest with the purchasing department. From the interview reports it is quite evident, however, that the responsibility of the purchasing department for material price standards is more largely a matter of predicting what the materials are going to cost than it is for buying at the standard price. The attitude generally observed has been expressed by a writer on the subject as follows:

> "These variances are not accepted, per se, as evidence that the purchasing department did a bad or good job of purchasing if the actual costs are greater or less than standard. It is taken as evidence of an error in forecasting. There are many things affecting the prices of materials used in our business that are beyond the control of the purchasing department, and if too much criticism were made of a purchasing loss against standard, the natural reaction of the purchasing agent would be to make the next standards high enough to protect himself against any contingency. So we merely say to him that he is expected to make the estimate of standard costs as nearly on the nose as he can, and it has worked out to our advantage in eliminating inflated purchase standards from the profit forecasts."[12]

[11] A manufacturer of electrical equipment prepares three price variance reports showing different degrees of detail according to the needs of the executives who receive each report. In the first of these reports, supplied to general company executives, materials are grouped into a few broad classes to reduce details to a minimum. The second report, designed to keep accounting department executives informed, shows price variances classified by the inventory account code. The third report, prepared for those desiring details in connection with making price quotations, making up product specifications, etc., lists variances by specific materials purchased.

[12] Thomas H. Patterson, *N. A. C. A. Bulletin*, April 1, 1945, p. 749.

In a few cases it was stated that various top executives are considered responsible for price variances because they choose sources of supply and negotiate purchase contracts. On the other hand, approximately one-third of the companies interviewed said that they considered no one responsible for price variances.

### *Follow-up of Material Price Variances*

Very few of the companies interviewed reported that they have any regular follow-up procedure for price variances. The companies reporting no regular follow-up procedure were asked what action would be taken if large price variances should occur. The usual reply was that the variance would be the subject of a special investigation to ascertain the cause and to determine what action could be taken.[18]

## Labor Performance Standards

One of the most fertile fields to which management can apply its efforts toward reduction and control of costs is the improvement of labor performance. A good set of operation time standards is well nigh indispensable for this purpose and the extension of these time standards into cost standards forms a logical completion of the labor cost control plan. The field studies showed that all of the 72 companies interviewed possess labor performance standards and that most of them utilize item and motion study methods to establish these standards.

### *Setting Labor Performance Standards*

The setting of labor performance standards is a process similar in approach to that employed for setting material quantity standards, but the techniques differ, as might be expected, where the problem is one of dealing with human operators rather than with inert substances. Establishment of standard operation times calls for determination of time needed to complete each operation when working under standard conditions. Hence along with operation timing goes the standardization of surrounding conditions that influence the effectiveness with which the employee performs his

[18] Examples of typical comments concerning this procedure are:

"The operating committee (composed of technical staff, sales, and production executives) discusses possible changes to reduce costs."

"Operating officials talk it over with the purchasing agent to check possibilities of improvement."

"We would consider the advisability of revising price standards."

task.[14] The scope of such a standardization plan may be indicated as follows:[15]

1. Consideration of layout, condition of equipment, the workplace, and transportation facilities to standardize these and to provide the best practicable arrangement under existing circumstances.
2. Establishment of control over materials in order that the workman may have the correct quality and quantity available in the proper place. This will require investigation of purchasing, receiving, and storeskeeping methods, of the plant transportation system, and the placing of materials at the workbench or machine.
3. Development of a system of planning, routing, and dispatching of work.
4. Provision of all needed instructions for the worker, either in the form of advance training or directions for each specific job.

The few companies that do not use time and motion study techniques for setting their labor performance standards obtain their standards by having the cost department study past performance or have the standards set by foremen who base them upon their experience, judgment, and knowledge of the operations. It ap-

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[14] John W. Sheetz ("The Industrial Engineer, the Cost Accountant, and Labor Standards," *N. A. C. A. Bulletin*, Nov. 1, 1946, pp. 317-318) has thus emphasized the need for method studies in setting labor standards:

"The chief value of motion and time studies lies in the standardization of conditions and methods, the former representing the material things surrounding the operation and the latter the motions executed by the worker in performing the operation. Conditions and method in actual practice are inseparable. Almost every change of condition requires a change of method and many changes of method require changed conditions.

"Independent time studies without method studies have no permanent value. . . . This is so because of the improvements which are automatically made by the production organization. . . . Time study which has not effected any improvements in methods nor eliminated any waste of time or of labor will soon make the standard obsolete because of improvements in methods that normally occur. The method study is necessary for two reasons; first, to bring the standard costs down to a reasonably low level, and second, to insure a standard which is not only correct at the moment but which will remain so until some fundamental change has been made in the operating practice."

[15] See W. L. Walker, "Job Time Standards," *N. A. C. A. Year Book*, 1928, pp. 43-61.

pears likely that in such cases standards are used principally for costing production rather than for cost control. However, a textile mill has recently established standards by this method because it was thus possible to put a standard cost plan into operation within a short period of time. It has also instituted a program of time and motion studies through which it expects to effect a gradual tightening of standards as the studies of manufacturing operations disclose ways to improve present methods.

*Responsibility for Setting Labor Performance Standards*

The setting of operation time standards requires an adequate technical background, for the standard setter must understand the processes used in the industry as well as the technique of time study. In addition, he should have sufficient independence to be impartial in establishing standards which serve as measures of individual efficiency and perhaps also as a basis for wage payment.

This combination of technical training and independence is usually obtained by delegating the setting of labor standards to staff specialists. Among the companies using time and motion study methods, the usual practice is to have a department to set labor standards. This department has various designations among which are time study, industrial engineering, standards, rate setting, wage incentive, methods, and cost control. In small companies one or more time study specialists attached to the production or engineering department set the standards. In one case the standards were originally set by an outside consultant and subsequently revised by the company.

Companies not using time and motion study methods usually reported that labor performance standards are set by either the cost department or by foremen.

*Tightness of Labor Performance Standards*

Time study men make allowances for fatigue, personal needs of operators, and unavoidable delays in setting time standards. A little over half of the companies make no additional allowances in their labor cost standards. The remaining companies usually include additional time to cover work rejected by inspectors or "fall-downs" (usually failure to meet piece rate standard). In a few instances, other items such as allowances for machine set-up

and change-over, machine breakdown, waiting time of operators, rework, and paid vacation time are included. However, most companies usually include the latter type of cost in the overhead budget instead of in the direct labor standards. This practice may be explained on the supposition that while these are includible in cost of production to the extent that they are unavoidable, they are not related to the efficiency of the individual operators. As such, they are best controlled through the overhead budget.

A number of companies stated that labor performance standards are, as a matter of policy, kept quite tight. Thus, one reported that its actual performance practically never exceeds 95 per cent of standard and usually ranges between 85 and 95 per cent of standard. These tight standards are designed primarily for cost control and where costing or pricing is the principal aim with control incidental, the labor standards tend to be looser.

Where favorable labor performance variances do occur, replies to questions with regard to causes of such variances indicated that most favorable labor performance variances arise from the following conditions:

1. Better than standard performance on day work since considerable fluctuation in output occurs when operators are paid by this method.
2. Labor-saving changes in methods, equipment, etc., which are not accompanied by concurrent changes in labor standards.
3. Mistakes in setting standards too loose.
4. Variations in performance which result when working conditions are not well standardized.

*Frequency of Review*

Since operation time standards often serve as the basis for an incentive wage payment plan as well as for other purposes, the time standards, once set, are usually not changed until a change in method of performing the operation requires that a new standard be set. Most of the companies interviewed have their operation time standards under constant review and change individual standards when changes are made in the jobs to which the standards apply. Such changes are necessary to maintain the usefulness of the standards for cost control.

*Responsibility for Labor Performance Variances*

Replies from the companies interviewed show that the foremen are almost always considered directly responsible for controllable labor variances and that production executives with supervisory authority over the foremen are held responsible for the foreman's success in controlling labor variances. However, foremen are not responsible for variances resulting from decisions which they did not have authority to make. For example, variances arising from such causes as the use of nonpreferred equipment are the responsibility of the departmental executive who directs the making of such changes.

*Labor Variance Pick-up*

Since application of standards at the source of the cost provides the most effective cost control, frequent comparison of actual performance with the standards might be expected. The field studies show that this process of matching actual performance with the related standard is brought closer to the individual operation for labor than it is for the other elements of cost.[16]

While clerical procedures for reporting labor time vary, they usually make use of either a periodic report or a job time ticket. In either case the labor variance is commonly computed on these labor time records. The causes of such variances are usually noted on the original record through use of a code.[17] The causes of the variances are thus initially stated in terms which are familiar to plant management.

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[16] This can be seen in the following tabulation of variance analysis practice reported from the field interviews.

| *Variances analyzed by* | *No. of companies* |
|---|---|
| Responsibility (i. e. by departments, cost centers, or individuals) | 49 |
| Operations | 27 |
| Products | 15 |
| Causes | 28 |
| Job orders | 9 |

The total of the figures listed above exceeds the number of companies interviewed since most companies make analyses of labor variances on more than one basis.

[17] For example, a manufacturer of textile machinery uses a piecework labor variance report on which variance causes are recorded as follows:

114—Nonpreferred equipment or rerouted work
115—Breakdown
116—Idle equipment
117—Other piecework allowances
119—Hard castings

A copy of the above report is supplied to foremen at the end of each week.

The field study disclosed a few companies which determine the labor cost variance only when a periodic physical inventory is taken. Most of these companies use time standards and calculate daily labor variances in hours for control purposes. The labor cost standards are used only for costing inventories, but the control use of standards is actually well developed although not exercised in terms of dollar costs.

*Variance Reporting and Follow-up*

Labor cost variances are usually brought to the attention of the individuals responsible for them by regular reports.[18] Reports prepared by companies interviewed generally contain other manufacturing cost variances in addition to the labor cost variance altho daily or weekly reports going to foremen sometimes are limited to labor variances. These latter reports are ordinarily for departments or cost centers which coincide with individual responsibility for labor costs. Summaries of the departmental variances are also prepared to provide top management with the overall picture of labor performance.

Approximately half of the companies interviewed have a regular follow-up procedure for labor variances while the remainder take follow-up action only when a large or unexplained variance occurs. Follow-up procedures observed are of the following general types.

1. The variances are discussed in a conference of executives interested. Causes and proposed remedies are brought up and corrective action may be recommended to line executives in charge of the operations producing the variances.
2. The staff department responsible for methods and standards investigates and determines what corrective action should be taken.

[18] The frequency with which such reports are prepared by 62 of the companies replying to this question is shown below.

| | *No. of companies* |
|---|---|
| Reporting variances monthly | 25 |
| Reporting variances weekly | 21 |
| Reporting variances daily | 7 |
| | 53 |

Nine companies do not have regular reports of labor variances. These companies are mostly small and those individuals concerned with labor performance are kept informed by personal examination of original time records, by oral presentations of variances, or by memos calling attention to unusual situations.

3. The responsible line executive investigates and institutes any changes that he thinks desirable.
4. Foremen responsible are required to report to their superior, explaining what caused the variances and what has been done or should be done to correct the situation.

The above are listed in the order of frequency with which they were mentioned in the field study.

## Labor Rate Standards

### *Use of Labor Rate Standards to Control Costs*

As with material prices, labor rates are determined largely by factors external to the individual company. Base rates paid are generally set by collective bargaining with unions or by the prevailing rate in the locality. Companies interviewed stated that variances due to rate changes are usually unimportant in amount since it is general practice to revise the rate standards when actual base rates of pay are changed. However, rate standards are not without value in control of costs since some rate variances result from factors which are controllable by management.[19]

After a basic wage rate has been set, management exercises further control over what it costs to do a specific job in the plant through the design and administration of its wage payment plan. This comprises the use of job rating to establish proper differentials between rates paid for various jobs and the development of employee compensation plans which provide an incentive for the worker to give adequate production in return for the time he spends in the plant. These methods will, of course, influence the standard rate set for a specific job.[20]

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[19] In the field study those companies developing labor rate variances were asked what caused rate variances to appear. The replies are tabulated below:

| *Cause of variances* | *No. of companies* |
|---|---|
| Variations from average rate used as standard, (due to overtime, learners, etc.) | 13 |
| Using man with wrong rate for job | 12 |
| Failure to have men on incentive | 5 |
| Rate changes, standards not revised | 7 |
| Variation in number of machines run per man | 3 |

It can be seen that management has control over some of these causes and that action could be taken to eliminate the related variances.

[20] As an illustration of practice in setting labor rate standards, one company has the engineering department specify on operation sheets the grade of labor to be used. The standard rate is then taken from a rate schedule prepared by the personnel department.

*Responsibility for Setting Labor Rate Standards*

The function of setting the labor rate standards is usually performed by the division of the business which has available the information from which standards are set. Thus in the field study the cost department was most frequently mentioned. Second in frequency was the engineering department (or a related division such as time study or standards), and in a few instances the rate standards are set by the personnel department.

*Revision of Rate Standards*

Approximately half of the companies interviewed change rate standards whenever actual rates of pay change. An equally large group of companies reviews rate standards periodically, with annual revision being the usual practice. Two companies use long period normal rates.

It is thus apparent that most companies keep their labor rate standards closely in line with the actual rate being paid. Even those companies which reported periodic reviews frequently stated that the time of review corresponds with regular review of union contracts so changes in wage rates resulting from revision of the agreement with the union are immediately reflected in new labor rate standards.

*Variance Analysis and Reporting*

Only one-third of the companies interviewed develop rate variances and the use of rate variances for cost control obviously is limited. The lack of variance analysis supports this conclusion.[21]

Those companies developing rate variances were asked whom they consider responsible for rate variances and in half of the cases the foremen were mentioned as having at least some responsibility. These companies stated that the causes of rate variances which they experienced were usually using a man with the wrong rate for the job, failure of operators to earn piece rates resulting in payment on a more expensive day rate basis, or having too many men per machine.

While various ways of informing the foremen of rate variances were found, the usual method was to have the rate variances included on a regular report showing all types of variances for

[21] Only 7 companies analyze rate variances by cause. However, 16 companies determine rate variances by departments or cost centers which, to some extent, localizes responsibility.

which the individual foreman is held responsible. However, other techniques are also used to direct the foreman's attention to jobs needing action.[22]

Only two of these companies reported any regular follow-up procedure for rate variances. One assigns a cost control engineer to investigate and the other takes up the variance in a conference between management and the accounting department.

The remaining companies developing rate variances did not mention the foremen as responsible for labor rate variances, but list various executives such as department supervisors, factory superintendent, manager of industrial relations, and president. These companies generally state that their rate variances arise from changes in wage rates without corresponding changes in the standards, variations from the average rate used as a standard, and similar causes. Variance reports are usually made monthly and go to the executives responsible or interested. Three companies report discussion of the variances at regular meetings of executives and in one company the manager of industrial relations is responsible for investigating the variances.

### *Relationship Between Labor Standards and Incentive Wage Plans*

Standards by themselves do not control labor costs, for in order to realize the costs predetermined by the setting of standards it is necessary that actual operation times be kept in line with the standard times. Experience has shown that one of the most effective ways of enlisting the cooperation and efforts of production personnel in meeting standards is to provide a financial incentive for doing so. This takes the form of employee compensation plans wherein the amount of wages paid is tied to performance under the standards. For direct labor where production of each employee is usually rather easily measured, various incentive wage plans are used which base wages earned upon production in terms of pieces, standard hours, or points.

Successful operation of these incentive wage plans requires reliable operation time standards. These standards are the same as

[22] Thus one small company sends job record tickets showing variances to the foremen daily and in another company the timekeeper supplies the foremen with a daily list of operations on which piece rate was not earned in order that the foreman may know which jobs need his attention. This company stated that it had found that its foremen are thus enabled to make better use of their time since they need not watch the operators in order to find out which jobs need attention.

those upon which the standard labor costs are based. Through such use of the same standards management can maintain its control over operation of the wage plan by using information provided by the cost reports. Thus so long as labor performance variances are small management can rest assured that employee productivity, earnings, and labor costs anticipated when the wage plan was adopted are being maintained.[23]

With indirect labor it is more difficult to develop an incentive wage plan primarily because standards are not so easily set for the tasks performed as they are for most direct labor. However, in some cases incentive payments are based upon cost performance of the employees supervised or upon performance measured by a budget.[24]

That the use of incentive wage plans is widespread among companies using standard costs may be seen in the fact that 60 of the 72 companies interviewed stated that incentive payment plans either predominate or are important in their plants. When a straight piecework plan of payment is in force the piece rate establishes the standard labor rate for the operation. Here labor variances will arise only when work is done on an hourly basis instead of the piece rate or when special allowances are made. These are usually made to protect the employee from some condition beyond his control, such as irregularities in quality of materials, machine trouble, presence of learners in the labor force, etc. Standard cost rates based on piece rates do not include items like vacation pay and wage increases expressed in cents per hour. It appears to be common practice to treat these payments as overhead costs rather than as direct labor.

## Overhead Cost Standards

### *Problems in Control of Overhead Costs*

The general approach to control of overhead costs is basically no different from that applied to direct costs, for it proceeds by setting standards which are used to evaluate performance expressed in actual costs. However, the specific techniques of setting stand-

[23] For an illustration of an incentive wage plan tied in with standard costs, see "Installing an Incentive Wage Plan," by Charles M. Reinherr and Paul Griek, *N. A .C. A. Bulletin*, Jan. 1, 1946, pp. 383-400.

[24] For an example of a bonus plan for salaried employees which is based upon standards, see C. L. Kingsbury, "An Incentive Bonus Plan Based on Cost Efficiency," *N. A. C. A. Bulletin*, May 1, 1941, pp. 965-978.

ards and the application of these standards differ in several respects from the techniques used with direct material and direct labor.

In the first place, overhead covers a complex variety of costs, the individual components of which behave in different ways when activity in the plant increases or decreases. Some overhead costs vary directly and proportionately with activity, others follow activity but not in the same ratio, and still others are largely independent of activity. As a result the actual average unit cost fluctuates with changes in activity and for this reason overhead standards for cost control are set in the form of budgets which give the total amount to be spent at a given level of activity.

Another result of the complex nature of overhead costs is that control over various items of overhead rests with different individuals in the organization. For example, foremen in productive departments may be able to control usage of indirect labor, superintendents may control factory clerical expenses, and heads of service departments control costs of supplying heat, cleaning, and plant transportation. Responsibility for costs must therefore be carefully defined.

The presence in overhead of costs which do not readily respond to changes in production volume requires a different approach to control.[25] Ordinarily control efforts must be directed toward obtaining the best possible utilization of the facilities to which the costs are directly related.

### *Types of Overhead Cost Budgets Used*

There are two types of budgets for controlling the variable component of overhead costs. These are the flexible budget, which provides allowances which vary with activity in the department concerned, and the fixed budget which provides an allowance for

[25] As David B. Caminez has pointed out ("Budgets for Cost Control," *N. A. C. A. Bulletin*, Nov. 1, 1946, pp. 306-307), the manufacturing expense budget is really a consolidation of two separate budgets, i.e., a budget for fixed expenses and a budget for variable expenses. Usually the allowances in the fixed budget include the salaries and wages of supervisory and key personnel who would be retained on the payroll during a prolonged period of low-volume operations as during temporary shutdown conditions, the cost of fuel for heating, power demand charges, minimum maintenance to preserve buildings and equipment from deterioration, depreciation, property insurance, rentals, minimum telephone charges, etc. These things are fixed by managerial policy; an advantage of having them set up in detailed schedules is that they can then be reviewed and any desired changes made by management.

the specific activity level anticipated. When the flexible budget is used, it is generally expected that activity will fluctuate during the period the budget is in force and it is therefore necessary to have standards which show how expenses should change with volume. The fixed budget, on the contrary, is predicated on the expectation that activity will be at the level forecast and hence only one set of budget allowances is needed.

Approximately three-fourths of the companies interviewed in the field study were found to use a flexible budget while the remainder use a fixed type of budget.

An objection often made to the fixed budget is that control over expenses may be lost if the level of activity deviates materially from the level on which the budget is based. The flexible budget was originally developed to overcome this objection. However, a number of companies reported that they are able to plan their production for a sufficiently long period in advance to avoid fluctuations in activity which would weaken the effectiveness of a fixed budget for cost control. This is perhaps to some extent a reflection of current market conditions which allowed steady production at practical capacity.[26]

*Setting Overhead Budgets*

Usually the first step in determining overhead budget allowances is a study of past experience in the usage of indirect labor, supplies, and services.[27] Figures so obtained are then modified to reflect changes in wage rates, material prices, equipment in use, and any other known influences which will make future overhead costs differ from those incurred in the past. Further adjustment

[26] Even where a flexible budget is in use, fixed budgets may be necessary for some departments in which costs do not bear a definite relationship to the volume of production. An example in point is the research department.

[27] The length of past experience upon which budgets are based by 24 companies is given below:

| | *No. of companies* |
|---|---|
| Previous six months | 3 |
| Previous year | 10 |
| Two to five years | 8 |
| Ten years or more | 3 |
| | 24 |

While the accounting period immediately preceding is most commonly the only one considered when revising budgets from year to year, a number of companies indicated that they studied a longer period of expense history at the time the first budget was prepared.

is also commonly made by the exercise of managerial judgment. Thus allowances may be reduced or increased in comparison with past experience if management deems such action desirable.

Most companies budget overhead in dollars only. However, as with direct material and direct labor, overhead budget allowances may be based on determination of quantities (i.e. hours of labor, pounds of supply materials, kilowatt hours of electricity, etc.). The latter practice applies only to important items, minor items being stated as dollar allowances.

With overhead it is especially important that control be exercised at the source of the cost. After various prorations or distributions have been made the results of excess spending become diffused and it is virtually impossible to ascertain how much inefficiency has cost or who was responsible for it. The need for costing production generally leads to collection of overhead costs at specific cost centers. Up to this point, the accounting procedures can serve both the purposes of product costing and cost control, but after the costs directly controllable in the cost center have been distributed to other centers the figures lose their control value. General recognition of this may be seen in the practice found in the field study.[28]

Departmental cost control budgets usually are limited to repetitive operating expenses and exclude such items as major repairs, construction work, and other irregularly occurring or unusual expenditures. These are provided for in the general budget and the work is controlled by estimates for each job done. However, a few companies do include an extra allowance in foremen's regular operating budgets for specific jobs which have been approved and over which the foremen have supervision.[29]

[28] Somewhat over half of the companies interviewed include no prorated expenses in the budgets used for cost control purposes. The other companies do include prorated expenses in the control budget, but all pointed out that responsibility of the departmental executives ends with the expenses which they control and does not extend to the prorated items. In most cases the prorated expenses are included because the same statement is prepared for both cost control and product costing purposes, but a few companies indicated that they wished to tell the foreman the total cost of operating his department.

[29] Nonrepetitive maintenance and repair jobs such as overhauling motors and painting buildings are typical examples. One company has furnaces which are relined after two or three years of use. When this work is to be done, a special allowance for the work is placed in the control budget of that period. However, for production costing purposes, each period is charged with a portion of the cost.

*Service Department Costs*

The existence of service departments supplying services to productive departments raises a question of placing responsibility for costs of the various services. Approximately half of the companies interviewed charge these services to productive departments at standard rates which are based upon the expenses budgeted for the service department. The head of each service department is responsible for any controllable variances arising in his department. The budget of each productive department contains an allowance for the standard cost of the quantity of service which should be consumed. Hence, the productive department is responsible for the quantity of services used but not for the unit cost.

The remaining companies interviewed charge service department costs to productive departments at actual unit costs. Some of these companies hold the service department foremen responsible for service costs whereas some others consider the productive department foremen responsible. In a number of instances service department costs are not controlled with budgets or standards and actual costs are merely distributed to productive departments for costing products.

*Responsibility for Preparing Overhead Budgets*

The accounting department usually prepares the overhead budgets. Since these budgets are based largely on past experience, the accounting department has apparently been chosen for the task because the principal source of historical cost data is contained in the accounting records. Furthermore, the accounting department possesses the technical qualifications for organizing and shaping into useful form the record of past experience on costs. It is not responsible for performance under the budgets and hence has the independence needed to set fair standards.

Where the overhead budgets are not established by the accounting department, the task is usually assigned to a special department whose function it is to set standards.

In most of the companies interviewed executives of operating departments who are directly responsible for expenses aid in preparing their own budgets, approve the budgets before they are put into effect, or take both of these steps.[30] By this process their

[30] A textile manufacturer thus reports that a committee made up of the operating executive in charge, the foreman of the department, and the cost accountant prepares the budgets.

experience and knowledge of conditions is utilized in preparing the budgets and in addition better cooperation in use of the budgets as a tool for cost control results when the operating personnel participate in the process of standard setting. Several company executives commented to the effect that the budget conferences have a high value in making foremen conscious of the need for cost control.

*Revision of Overhead Control Budgets*

Companies interviewed usually revise overhead control budgets annually, although a few companies make revisions semiannually or quarterly. While a number of companies revise their budgets only when they consider it necessary instead of at regular intervals, all of these companies using their overhead budgets for cost control purposes have revised them within the past year.[31] Thus it may be seen that overhead control budgets are current.

*Overhead Variances*

It has been stated that budgets are prepared for each department or cost center and that these cost centers are the points at which control of overhead costs is exercised. The overhead variances developed for control purposes are obtained by comparing actual expenses with the standard expenses contained in the budget. This comparison is made for each item of expense controllable by the supervisor of the cost center. If desired, individual variances can be analyzed to determine specific causes, although this was usually found to be done only when significant variances occur.

The over-all overhead variances are reported in various ways. The field study showed that most companies develop a controllable variance and a volume variance. A few companies have three overhead variances, developing volume, spending, and efficiency variances.

Responsibility for meeting the budgets should be fixed as near as possible to the point where action can be taken to control expenses. Authority to control expenses and responsibility for them

[31] A textile company has described its method as follows: in the lower left-hand corner of the cost card there is a space for budget changes. Whenever operating conditions affecting costs have been changed by management since the standards and budget allowances were set, the budget allowance is properly adjusted. Such items as plant-wide increases, changes in manufacturing specifications, and introduction of new machinery are handled here. In this way the budget is always up to date.

must be distinctly defined, for if there is overlapping the budget will not operate satisfactorily.

Volume variances are rather commonly viewed as the result of outside circumstances over which the business has no control. While this may be true to a certain extent it would seem that it is the function of management at the over-all planning and policy-making level to secure a proper balance between production facilities and sales in order that losses from unutilized capacity may be kept at a minimum. For this reason some companies consider top management responsible for volume variances. Such control is necessarily a long-range problem and a volume variance in any given period may be something over which little direct control can be exercised.[82]

### *Overhead Cost Control Reports*

Reports generally show the budgeted expense, actual expense, and variance for the current period and cumulatively for the year to date. A report is prepared for each department or cost center listing items of expense incurred in the department and summary reports covering broader areas are prepared for executives above the rank of foreman. When the reports contain expenses which are not controllable by the person receiving the report, these expenses are often grouped together at the end.[83]

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[82] A few companies reported exceptions to the above attitude toward volume variances. These are interesting in that they disclose a field where some immediate control over volume variances may be possible. Practice of these companies is summarized below.

*Company No. 1*—The sales manager is considered responsible for volume variances since he is expected to obtain the volume of business used in establishing the standard overhead rate.

*Company No. 2*—Departmental supervisors are held responsible for idleness due to machine breakdowns, failure to have materials or operators ready, and similar causes of delay in the factory.

*Company No. 3*—A manufacturer of office machines has a production stabilization program whereby the factory works at a steady rate and product is accumulated in inventory during seasonal periods of slack sales. The production planning department is held responsible for volume variances in production since such variances result from faulty planning of operations.

[83] As an illustration, the practice of a textile company is cited below.

A summary sheet shows variances for the entire plant by type of expense with a breakdown between variance due to volume and that due to controllable factors. This summary sheet is distributed to factory management, divisional management, controller's office, and to the vice president in charge of manufacturing. Detailed sheets are prepared for each department showing a comparison of actual expense with the budget adjusted for volume. These latter go to foremen and to factory management.

Most companies prepare reports on overhead budget variances monthly, although a few companies reported the use of weekly reports. The latter are sometimes limited to certain items of expense. Thus one company prepares weekly reports on indirect labor and also uses a monthly report covering all budgeted overhead expenses.

*Follow-up Procedure for Overhead Costs*

With only a few exceptions the companies covered in the field study have a regular follow-up procedure for variances from overhead budgets. The general method is the same as for material quantity and labor performance variances. Thus the procedures reported most frequently are discussion of variances at conferences, investigation by executives with line authority over foremen, and investigation by staff departments.

*Incentive Payment Plans Based on Budgets*

Only a few companies reported the use of incentive payment plans for foremen based upon the overhead budgets. Several companies expressed interest in eventual development of such incentive plans but do not have them in effect at the present time.

*Conclusions Regarding Use of Standards to Control Overhead Costs*

It is apparent that the control of overhead expenses is usually weaker than is control of direct costs. Thus many companies in which direct material and direct labor are closely controlled by standards have little in the way of overhead expense standards. Others do possess overhead budgets, but inquiry disclosed them to be used mostly for costing production. Furthermore, it seems that expenses of service departments are less effectively controlled than are the indirect expenses incurred in productive departments.

Doubtless this relative weakness of cost control stems in part at least from the difficulties involved in setting reliable standards for overhead costs. Where activities are varied and the individual items of cost are numerous and perhaps rather small, they are not as readily brought under control as are direct costs which arise from simple repetitive operations. Moreover, responsibility for the incurrence of overhead costs is not clearly defined in many organizations and control is therefore practically impossible to establish.

## Conclusion

### *Factors Affecting Usefulness of Standard Costs for Cost Control*

Most of the companies interviewed regard usefulness in aiding cost control to be a major justification for employing standard costs. The effectiveness with which this aim is achieved varies. Based upon observations made in the course of the field study, the following conditions seem to accompany successful use of standard costs for controlling costs:

1. Management is interested in controlling costs, is aware of the advantages offered by standard costs for this purpose, and uses the variance reports.
2. Standards are reliable, current, and represent good but attainable performance. Management and operating personnel both have confidence in the correctness and fairness of the standards.
3. Reports are prepared which keep management at all levels informed of progress relative to standards.
4. The system of record keeping is as simple as possible.

On the other hand, conditions which appear to stand in the way of successful use of standard costs for cost control are:

1. Management is uninterested or unaware of the usefulness of standard costs. For this reason several companies having well-developed standard cost plans for product costing make little use of their standard costs for control purposes.
2. Standards are out of date, unreliable, or are designed to give product costs rather than operation costs. As a result of the first two conditions the standards are not taken seriously. The result of the latter condition is that variances cannot be traced to their sources without laborious investigation or are determined too late to be of much interest.
3. Reports are not prepared in terms which management understands. Executives with a production or sales background may not be able to interpret accounting terminology.

Several factors sometimes mentioned as determining the success with which standard costs can be used did not appear to be significant. These are:

1. The nature of the processes used or the products made. Companies were found using standard costs successfully in simple process type industries, in industries carrying on mass production of standard products of many types, and in job order industries where production was complicated and products built to special order. However, it was evident that the specific plan of using standard costs must be adapted to the needs of the company.
2. Size of the company. When a company is large enough to need records and reports to keep management in touch with operations, standard costs seem applicable.
3. Rapidly changing conditions of the postwar period. It seems that more frequent revision of standards is necessary, but effective use of standards was seen to be possible.
4. Cost of operating the standard cost plan. Most companies stated that they had obtained distinct economies in the operation of their cost systems through the use of standard costs. In some cases comments were made to the effect that introduction of standard costs required increased expenditures for engineering personnel needed in setting and maintaining standards. However, these companies were agreed that such additional expenses were more than offset by savings derived from improved control over production costs.

Numerous companies were encountered which were either revising and improving existing standard cost plans or introducing standard costs for the first time. These companies, together with those which had considerable experience with their standard costs, were, with few exceptions, agreed that standard costs provide management with a highly effective tool to aid in control of costs.

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